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(57) ABSTRACT:

The present invention relates to a device pertaining to a headset (1) for listening to sound, especially stereo sound, which headset (1) has at least two drive elements (2a, 2b, 2c, 2d) which provide sound for listening, the sound being channelled directly or indirectly from at least one drive element (2a, 2b, 2c, 2d) to both ears of a listener in such a way that at least one primary sound (5a, 5b, 5c, 5d) and at least one secondary sound (6a, 6b, 6c, 6d) from the same drive element (2a, 2b, 2c, 2d) are heard by the listener's two ears for at least a certain period of time, the secondary sound (6a, 6b, 6c, 6d) reaching at least one of the ears later than the primary sound (5a, 5b, 5c, 5d).

The present invention relates to a device pertaining to a headset and affording the possibility of listening with better sound reproduction than is possible according to the state of the art by means of crossfeed.

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Headset designs of the kind here concerned currently on the market are used for listening to ordinary stereo recordings. Such headsets do not reproduce correctly the intended sound image, since the listener perceives that the sound is reproduced in the head with an overdriven 10 stereo effect and no depth in the sound image. This is because the recordings are made for listening to via loudspeakers. A good stereo recording in a good sound system results in the loudspeakers reproducing the sound in good acoustic conditions so well that the width, depth and also, in some cases, the height of the sound are 15 perceptible. This is because the left ear and the right ear form their sound image from the left loudspeaker, since the distance between the ears results in a time shift of about 0.5 ms in the time the sound takes to reach the respective ears. The same does of course also occur with the left loudspeaker [MEANING "the right 20 loudspeaker"?]. This phenomenon, known as crossfeed, is interpreted by the listener as the sound source being situated outside his/her head. Ordinary headsets cannot provide this crossfeed, since the left and right channels are separated all the way to the respective ears from the small loudspeakers in such headsets, hereinafter called drive 25 elements. In other words, the left channel is heard by the left ear only and the right channel by the right ear only. A different design according to American patent US 42 97 535 tried to imitate crossfeed by connecting an extra tube to the left earphone and an extra tube to the right earphone. In such headsets, ordinary stereo sound is heard 30 from the normal drive elements. What is heard from the extra tubes is the time-shifted sound from two extra drive elements connected to the other ends of these tubes. That is an extremely expensive, impractical and complicated solution involving four channels and four

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drive elements carrying different signals. It is also possible to achieve crossfeed in the actual headset by electronic processing of the stereo signal between the channels via a crossfeed filter, which entails major disadvantages in that they have to be connected between 5 the input and output stages of the sound system amplifier or else be incorporated in a separate headset amplifier. There are also headsets with a large enclosed space according to German published specification 2 510 459, wherein the drive elements are situated inside the space, resulting in acoustic cross-circuiting which spoils 10 the listening experience. Moreover, that design achieves no crossfeed, because the space cannot simulate the time shift, since it is too large and too long and also causes various sound reflections and standing soundwaves against the walls of the space. That design cannot provide the sound image which loudspeakers can. Headsets which 15 reproduce sound recorded on dummy heads, with the microphones situated in the dummy's ears, are currently used. The resulting sound image is perceived as more realistic than is possible when listening to loudspeakers reproducing ordinary stereo recordings. This is therefore due not to the design of the headsets but to the actual 20 recording. **[FULL STOP MISSING AT END OF SENTENCE]**

An object of the present invention is to eliminate the disadvantages experienced with the aforesaid designs by placing a crossfeed tube between the drive units.

25 The invention presents a device pertaining to a headset which by crossfeed via at least one crossfeed tube between the drive elements provide sound reproduction from the headset which is similar to the experience of listening to stereo sound from loudspeakers in a room. 30 According to the invention, the headset has at least a drive element for the right ear and another drive element for the left ear. At least their front sides comprise structural elements which hold together the headset's various parts round the drive elements. The

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drive elements are not sealed rearwards but allow the sound to flow freely out. Their front sides direct the sound forwards, preventing any acoustic cross-circuiting, with the result that the sound created in the drive elements is led to at least the respective sound 5 channeller, which is a point where the sound is distributed and which comprises at least two channels which channel the sound in at least two different directions, so that part of their energy content, hereinafter called primary sound, is channelled through at least the respective primary sound tubes from the respective drive elements, 10 which primary sound tubes are in principle of the same length as the distance from the respective channeller to the ear where the sound is heard, the right ear hearing primary sound from the right drive element and the left ear hearing primary sound from the left drive element. Another part of the energy content of the sound delivered 15 from the drive elements, hereinafter called secondary sound, is channelled via the channeller through at least one crossfeed tube which extends in principle between the drive elements and wherein the sound is carried to the second sound channeller and thereafter to and through the second primary sound tube and thereafter proceeds to the 20 ears, so that the left drive element delivers secondary sound to the right ear and the right drive element delivers secondary sound to the left ear. The approximately 15-25 cm length of the crossfeed tube results in the secondary sound reaching the ear about 0.45-0.75 ms 25 later than the primary sound, with the result that the brain interprets the sound perception in a similar way to the sound from the loudspeakers in a stereo system, i.e. the sound is experienced as being outside the head. In a preferred embodiment of the invention, a crossfeed tube between the structural elements serves as carrier for the drive elements and is connected to the sides of the structural 30 elements. A primary tube for each drive element is connected to the front side of each structural element and forms in principle an angle of 90 degrees with the crossfeed tube. The sound from the drive elements has a primary propagation direction which in principle

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coincides with the propagation direction of the primary tube, which means that the bulk of the sound is led through the primary sound tubes directly to the respective ears. The rest of the sound is led to the crossfeed tube, in principle 90 degrees to the side. The time 5 the secondary sound takes to pass through the crossfeed tube delays its arrival at the ear by about 0.6 ms as compared with the primary sound. This delay causes the ears to perceive the sound reproduction as very similar to stereo sound from the loudspeakers in a stereo system. This embodiment of the invention will be simple and light in 10 weight and therefore inexpensive to manufacture and also easy to use. It is also possible, in an alternative embodiment of the invention, for the crossfeed tube to be curved in order to be ergonomically correct by conforming to the shape of the head. It is possible to incorporate articulations and telescopic adaptation of the length of 15 the tubes in order to be able to adjust them to different head shapes. It is also possible according to the invention to provide the earphones with dual primary tubes, one of them leading in from behind the ear, the other from the front to each ear. Dual crossfeed tubes are used between the drive elements, making it possible to listen also 20 to four-channel stereo with four drive elements. This four-channel model comprises in principle dual headsets which have to be acoustically shielded from one another. It is thus possible to simulate sound which comes from behind, making it possible to experience so-called "surround sound". It is of course also possible 25 to furnish the connection to the ears with earphone pads in order to conveniently provide contact with the ends of the primary sound tubes. Adjustable dampers may be used for calibrating the distribution of primary sound and secondary sound to the ears. The delay of the secondary sound may also be regulated by modifying the length of the 30 crossfeed tube as desired by the listener. The greatest advantages of the invention are therefore being able to manufacture an ergonomically correct headset which is of low weight, inexpensive and easy to use.

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Moreover, its construction is so simple that it will be of great operational reliability.

5 The invention is described in more detail below on the basis of a preferred embodiment example with reference to the attached drawings, in which

10 Fig. 1 depicts a section through a headset according to the invention,

Fig. 2 depicts a section through parts of a headset according to the invention,

15 Fig. 3 depicts side views of various crossfeed tube adjustment facilities according to subfigures a-c.

Fig. 4 depicts a perspective view of a headset with four drive units being used by a listener.

20 The embodiment of the invention illustrated in Fig. 1 refers to a headset 1 with "a" reference notations for the left side and "b" reference notations for the right side for channel 1 and channel 2, which headset comprises two structural elements 12a and 12b which support drive elements 2a,2b and connect together two sound 25 channellers 3a,3b and the crossfeed tube 4, which sound channellers 3a,3b distribute the sound from the drive elements 2a,2b in such a way that primary sounds 5a and 5b are led into and through primary sound tubes 7a,7b, and secondary sounds 6a,6b are led into and through the crossfeed tube 4 and thereafter proceed into and through the primary 30 sound tubes 7a,7b, which are in principle of the same length. The crossfeed tube 4 takes the form of a carrier 9 which holds together the structural elements 12a,12b, whose front sides 11a,11b anchor the primary sound tubes 7a,7b. The sides 10a,10b of the structural

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elements 12a,12b anchor the crossfeed tube 4. The primary sounds 5a,5b propagate from the drive elements 2a, in principle in the propagation directions 8a,8b, and the secondary sounds 6a,6b in the propagation directions 13a,13b. The primary sounds 5a,5b and the 5 secondary sounds are led out at the ends 14a,14b.

In the embodiment of the invention depicted in Fig. 2, the drive element 2b is installed in the structural element 12b. The sound channeller 3b distributes the primary sound 5b and the secondary sound 10 6b as described above. To allow more exact adjustment of the distribution of these sounds so that the listener hears a sound conforming to his/her wishes, the primary sound tube 7b and/or the sound channeller 3b are/is provided with at least one primary damper 15b which is adjustable from a fully open state to a fully closed 15 state. At least one secondary damper 16b is also placed in the sound channeller 3b and/or in the crossfeed tube 4 and are adjustable in the same way as the primary damper 15b. The drive element 2b [2a?] is likewise arranged as described above. It is thus possible to adjust 20 the distribution and strength of primary sound 5a,5b and secondary sound 6a,6b with a great deal of freedom of choice. To be able to adapt the shape of the headset 1 to the position of the listener's ears and the shape of his/her head, the headset 1 needs to be adjustable. It is therefore provided with at least one adjustment facility 17a,17b which may take such forms as snake configuration, 25 bending notch, ball joint, hinge joint or the like, applied at at least one of such points as the structural element 12a,12b, the primary sound tube 7a,7b or the crossfeed tube 4, so that greater spacing, different angles, widths, heights etc. can be set without having to alter the length of the secondary sound tube 6.

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Fig. 3 shows how the length of the crossfeed tube 4 can be varied to increase and decrease the delay of the arrival of the secondary sound 6a,6b at the ends 14a,14b of the primary sound tubes 7a,7b so that the

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listener can him/herself set this delay. Subfigure a depicts a telescopic configuration, subfigure b a concertina configuration, subfigure c a stretchable elastic tube.

5 Fig. 4 depicts a headset 1 with dual drive units 2a,2b and 2c,2d for listening to four channels, the "a" and "c" notations pertaining to the left side and the "b" and "d" notations to the right side, with the consequent possibility of achieving "surround sound" by sound being experienced as also coming from behind. This entails two
10 crossfeed tubes 4 carrying the secondary sound 6a,6b,6c,6d, one of them serving two drive units 2a and 2b, the other serving the drive units 2c,2d. In other respects the technology works as described above except that the primary sound 5a,5b,5c,5d is led through the primary sound tubes 7a,7b,7c,7d to earphone pads 20a,20b situated at
15 the ends 14a,14b,14c,14d, whereby the sound heard from the ends 14a and 14b is led in from in front and that from the ends 14c,14d is led in from behind.

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Claims

1. A device pertaining to a headset (1) for listening to sound, especially stereo sound, which headset (1) comprises at least two drive elements (2a, 2b, 2c, 2d) which provide sound for listening which is channelled directly or indirectly from at least one drive element (2a, 2b, 2c, 2d) to both ears of a listener, at least one primary sound (5a, 5b, 5c, 5d) and one secondary sound (6a, 6b, 6c, 6d) from the same drive elements (2a, 2b, 2c, 2d) being audible to both of the listener's ears for a certain period of time, while the secondary sound (6a, 6b, 6c, 6d) reaches at least one ear later than the primary sound (5a, 5b, 5c, 5d), which is later led through at least one primary sound tube (7a, 7b, 7c, 7d), and which secondary sound (6a, 6b, 6c, 6d) is led through at least one crossfeed tube (4) and thereafter proceeds through the primary sound tube (7a, 7b, 7c, 7d) and out at at least one end (14a, 14b, 14c, 14d), **characterised in that** the sound from the drive element (2a, 2b, 2c, 2d) is distributed in at least one sound channeller (3a, 3b, 3c, 3d) before it is led through the primary sound tube (7a, 7b, 7c, 7d) and/or the secondary tube (4), which sound channeller (3a, 3b, 3c, 3d) distributes the sound in such a way that the primary sound (5a, 5b, 5c, 5d) propagates in at least one propagation direction (8) which coincides with that of the primary sound tube (7a, 7b, 7c, 7d), and that the secondary sound (6a, 6b, 6c, 6d) propagates in at least one other propagation direction (13) which in principle coincides with the propagation direction of the crossfeed tube (4), which crossfeed tube (4) is variable in length to be able to increase the delay of the arrival of the secondary sound (6a, 6b, 6c, 6d) at the ends (14a, 14b) of the primary sound tube (7a, 7b, 7c, 7d), which length of the crossfeed tube (4) is about 15-25 cm, whereby the secondary sound reaches the ear about 0.45-0.75 ms later than the primary sound (5a, 5b, 5c, 5d).

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2. A device according to claim 1, **characterised** in that variation of the length of the crossfeed tube (4) is effected by means of at least one of such facilities as telescopic configuration (a), concertina configuration (b) and stretchable elastic tube (c).

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3. A device according to any one of the above claims, **characterised** in that the crossfeed tube (4) provides connection between at least two structural elements (10a,10b) and/or at least some of the drive elements (2a,2b,2c,2d).

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4. A device according to any one of the above claims, **characterised** in that at least one primary sound tube (7a,7b,7c,7d) and/or at least one sound channeller (3a,3b,3c,3d) comprises at least one primary damper (15a,15b,15c,15d).

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5. A device according to any one of the above claims, **characterised** in that at least one sound channeller (3a,3b,3c,3d) and/or at least one crossfeed tube (4) comprise(s) at least one secondary damper (16a,16b,16c,16d).

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6. A device according to any one of the above claims, **characterised** in that the headset (1) is adaptable to the shape of the listener's head and the position of his/her ears by comprising at least one adjustment facility (17a,17b,17c,17d) in the form of, for example, a snake configuration, bending notch, ball joint, hinge joint or the like, which adjustment facility (17a,17b,17c,17d) is applicable to at least the structural element (12a,12b), the primary sound tube (7a,7b,7c,7d) or to the crossfeed tube (4), making it possible to set greater spacing or different angles, widths and heights without altering the length of the crossfeed tube (4).

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7. A device according to any one of the above claims, **characterised** in that the headset (1) is driven by four drive elements (2a, 2b, 2c, 2d) for listening to four channels and comprises four primary sound tubes (7a, 7b, 7c, 7d) and two crossfeed tubes (4) which together carry the secondary sound (6a, 6b, 6c, 6d) and the primary sound (5a, 5b, 5c, 5d).

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8. A device according to claim 7, **characterised** in that the ends (14a, 14b, 14c, 14d) are provided with earphone pads (20a, 20b) whereby the sound from the ends (14a, 14b) is led in from the front and that from the ends (14c, 14d) is led in from behind.

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9. A device according to any one of the above claims, **characterised** in that the front side (11a, 11b) of at least one structural element (12a, 12b, 12c, 12d) is connected to at least one primary tube for each drive element, the primary sound tubes (7a, 7b, 7c, 7d) forming in principle an angle of 90 degrees with the crossfeed tube (4).

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20 10. A device according to claim 7, **characterised** in that the crossfeed tube (4) and the primary sound tubes (7a, 7b, 7c, 7d) constitute two acoustically separate systems, thereby creating a four-channel headset (1) which in principle comprises two separate headsets (11) acoustically separated from one another.

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